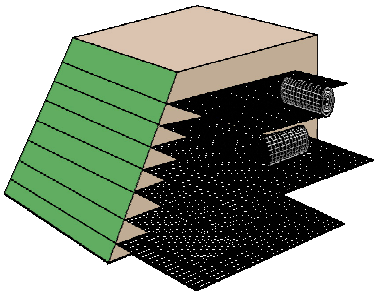
Cost Effective Solutions for

Difficult Site Conditions

- Caltrans Presentation
- November 3, 2005



Tensar

Tensar Structural Geogrids

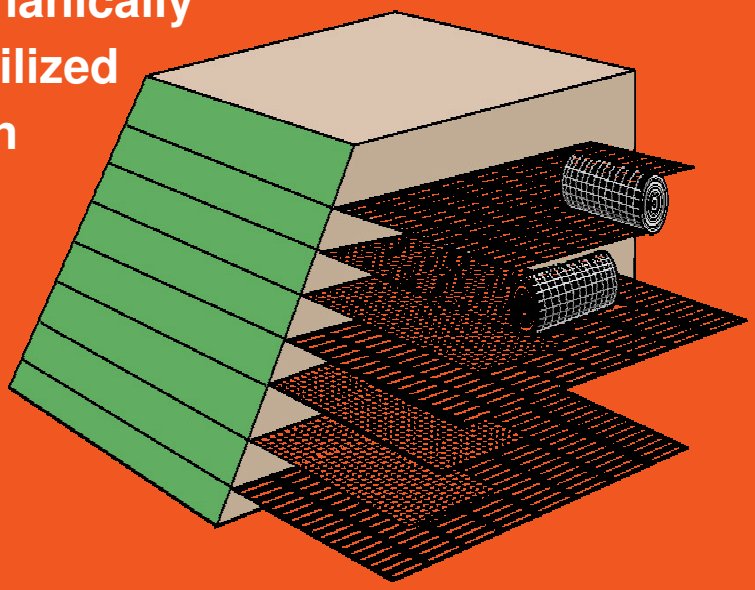
Tensar BX Geogrids

Tensar UX Geogrids

Reinforced Slopes

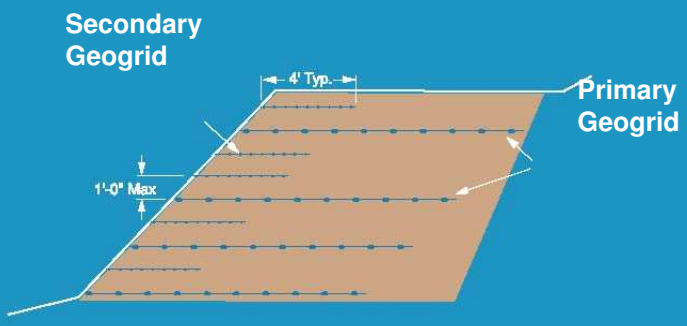
- CROSS SECTIONS
- INSTALLATION OF REINFORCED SLOPES
- APPLICATIONS

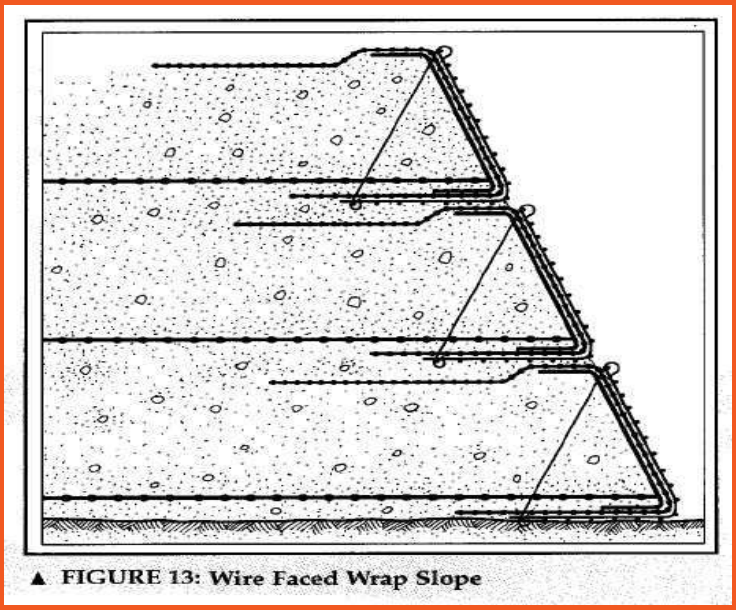
Mechanically
Stabilized
Earth



Mechanically Stabilized Earth, MSE

Slopes 1:1 and Flatter

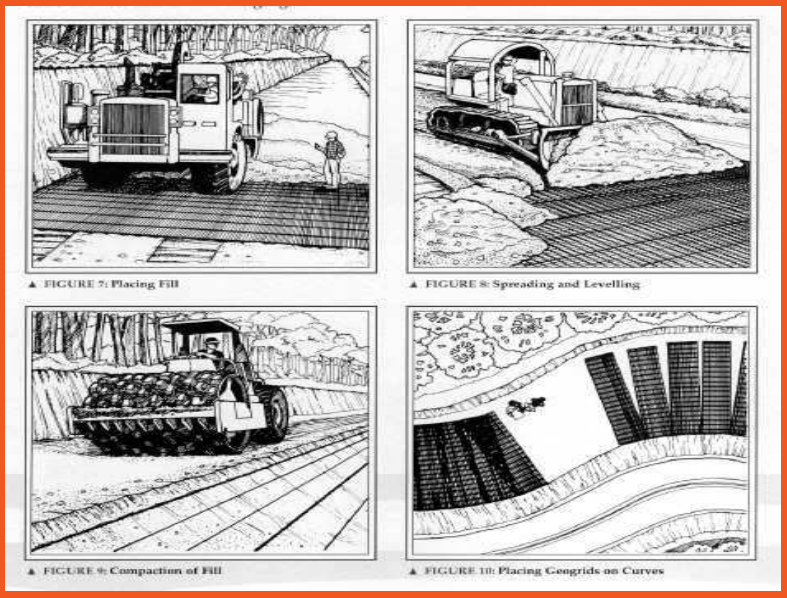




▲ FIGURE 13: Wire Faced Wrap Slope

WELDED WIRE FORM FACE


DO NOT ENTER



▲ FIGURE 7: Placing Fill

▲ FIGURE 8: Spreading and Levelling

▲ FIGURE 9: Compaction of Fill

▲ FIGURE 10: Placing Geogrids on Curves

FILL PLACEMENT AND COMPACTION


637D


San Ramon

Applications

Gold Run – I80

Gold Run – I80

Gold Run – I80

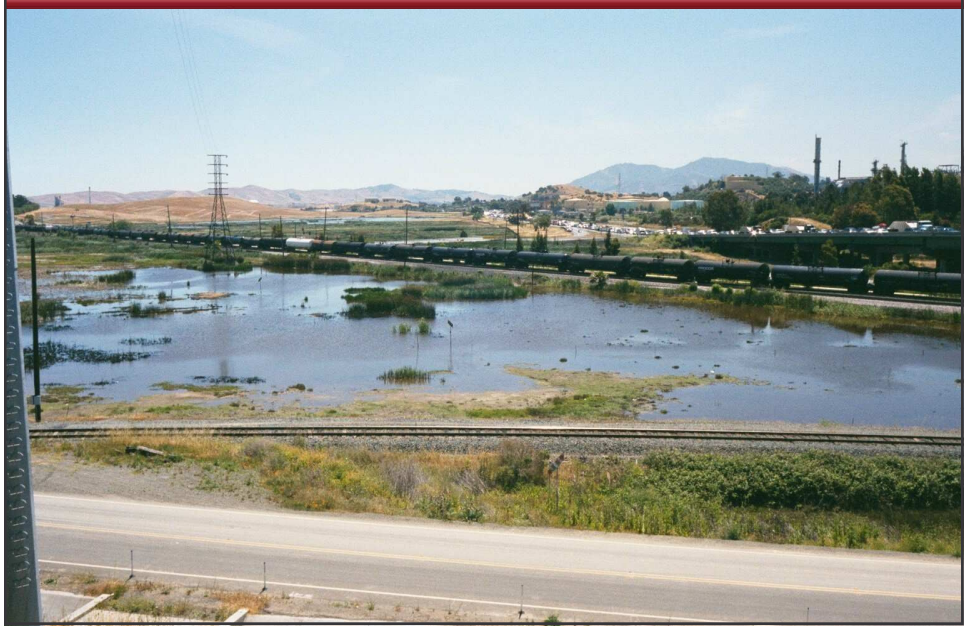
Ortega Highway – Hwy 74

Ortega Highway – Hwy 74

Ortega Highway – Hwy 74

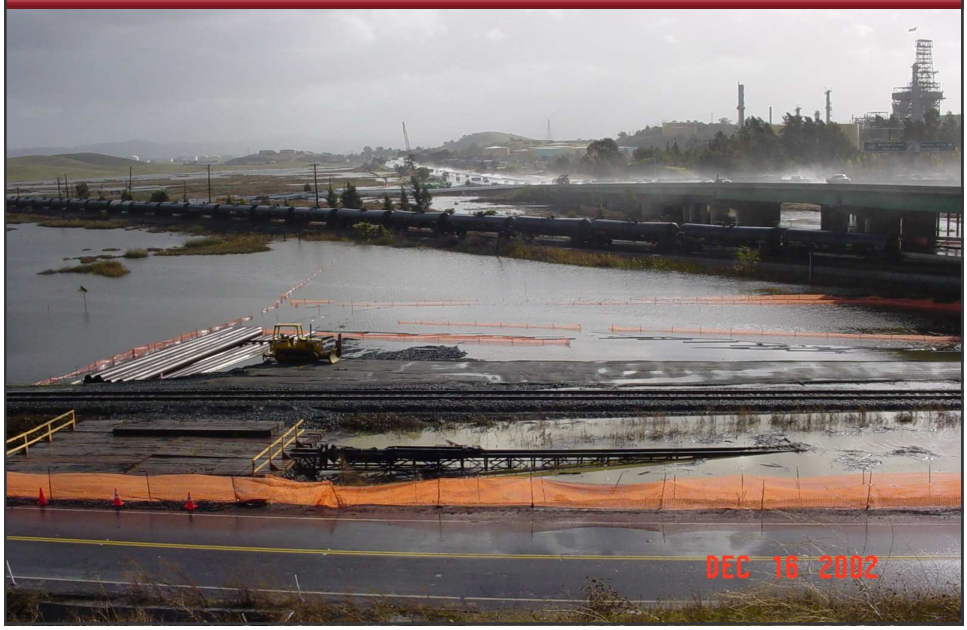
Ortega Highway – Hwy 74

Marina Vista – I680



Marina Vista – I680

Marina Vista – I680



Marina Vista – I680

Marina Vista – I680

Geogrids

Getting the end product you thought you specified

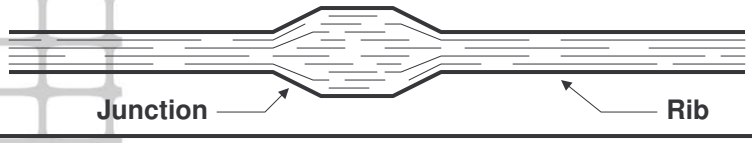
Geogrid Reinforced Systems

- Product Consistency
- Verifiable LTDS
- Standard Construction Guidelines
- Standard Construction Details
- Design Consistency

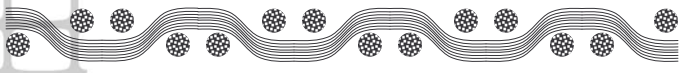
Non-Metallic Soil Reinforcements

Fundamental Composition

Punched and Drawn Geogrid: Solid sheet with highly oriented ribs



Geotextile: Filaments to bundled, twisted yarns to weaving or knitting



Woven geogrids are like geotextiles woven with open apertures

Long Term Design Strength

- Design of all geosynthetic reinforced MSE structures are designed around the Long Term Design Strength (LTDS) of the reinforcement.
- LTDS = Ultimate Tensile Strength divided by three reduction factors, what are they?
- **Creep**
- **Aging (Durability)**
- **Installation Damage**

Long Term Design Strength (T_{LTDS})

$$T_{LTDS} = T_{ult} / (Fs_{creep} \times Fs_{aging} \times Fs_{inst.})$$

- T_{ult} – Ultimate Tensile Strength
- Fs_{creep} – Factor of safety for creep of the polymer
- Fs_{aging} – Factor of safety for chemical and biological degradation
- Fs_{inst} – Factor of safety for installation damage

Ultimate Tensile Strength (T_{ult})

GEOGRIDS

- Ultimate tensile strength is determined using ASTM 6637
  - Slack Tension load is limited to one application of 50 lb

GEOTEXTILES

- Ultimate tensile strength is determined using ASTM 4595
  - A repetitive 50 lb preload is allowed for the alignment of fibers and to remove the slack inherent in woven material.
- In both cases if a preload was used to determine ultimate tensile strength the preload should be repeated during installation

Evaluation of MSE Systems

- Industry Evaluation of Geogrids
  - Geosynthetic Research Inst. (GRI)
- Third Party Evaluations of MSE Systems
  - Highway Innovation Technology Evaluation Center (HITEC)
  - National Cooperative Highway Research Program (NCHRP)

MSE Retaining Wall HITEC Reports

- *VERSA-LOK® Miragrid® Reinforced Soil Wall System (#40708)*
- *Anchor Wall Systems' Landmark Reinforced Soil Wall System with T.C. Mirafi's Miragrid® & Miratex® Geogrid Reinforcement (#40677)*
- *Tensar ARES™ Retaining Wall System (#40301)*
- *Tensar Mesa® Retaining Wall System (#40358)*

Determining Product Reduction Values

- The manufacturer or an independent body?
- Highway Innovative Technology Evaluation Center (HITEC)
- Reviewed Both Tensar (HDPE) and Mirafi (PET) geogrids for retaining wall applications, soon others…
- Let's see what they said about these different product types

Creep

the gradual, permanent deformation produced by a continued application of stress or heat

HITEC

HDPE	RF = 2.65
PET	RF = 1.90

Manufacturer

From published information

HDPE	RF = 2.2-2.4
PET	RF = 1.67

Aging

Degradation from Biological or Chemical reaction

HITEC & FHWA

HDPE (all pH ranges)	RF = 1.1
PET (pH>5,<8)	RF = 1.15
PET (pH>3,<9)	RF = 1.30

Manufacturer

HDPE (all pH ranges)	RF = 1.0
PET (pH>5,<8)	RF = 1.1
PET (pH>3,<9)	RF = 1.1

Installation damage

The geosynthetic must be reduced by the amount of damage caused by installation of the backfill

From HITEC Evaluation

Polymer Type	Report "Sand, Silts and Clays"	NHI 043, Type 2 Sand & Gravel D_{max}= 20 mm D_{50}=0.7 mm	NHI 043, Type 1 Sand & Gravel D_{max}= 102 mm D_{50}=30 mm
Polyester (PET)	1.05	1.15 – 1.3	1.3 – 1.7
High Density Polyethylene (HDPE)	1.05	1.1 – 1.15	1.25

Geogrid Reinforced Systems

- Product Consistency
  - Complete quality control of all the components
- Verifiable LTDS
  - Creep-Durability-Installation damage-
  - HITEC
- Standard Construction Guidelines
  - Proper placement of the product & inspection
- Standard Construction Details
  - Dealing with field conditions & inspection
- Design Consistency
  - Setting the standards for your design team